



Semester 2 Examinations 2021 / 2022

Exam Code(s) 4BCT, 3BP, 4BP
Exam(s) Fourth Year Computer Science and
Information Technology
Third and Fourth Year Electronic and
Computer Engineering

Module Code(s) CT414
Module(s) Distributed Systems

Paper No. 1

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Instructions: Answer any 4 out of the 5 questions.
All questions carry equal marks.

Duration 2 hrs
No. of Pages 4
Department(s) School of Computer Science

Requirements:

Release in Exam Venue	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
MCQ Answersheet	Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>
Handout	None			
Statistical / Log Tables	None			
Cambridge Tables	None			
Graph Paper	None			
Log Graph Paper	None			
Other Materials	None			
Graphic material in colour	Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>

1. Using Java Remote Method Invocation, write the Java code for a remote compute server application that could be used to remotely execute arbitrary Task objects. The server allows clients to submit Task objects, i.e. objects that implement the Task interface, for remote execution on the server, and clients are then returned the result as a Java object. The design of the system should make it possible for new Task classes to be easily added to the system in the future, making the system very flexible. The design should use Java RMI and Object Serialisation to submit Task objects and to return the result back to the client.

The following Java interfaces / classes should be provided:

- *Compute* - this remote interface should provide a method to upload Task objects to the server and to then run the task and return the result back to the client when execution is complete. 4 MARKS
- *Task* - this interface should define an arbitrary Task object that may be passed as a parameter to the compute server. 4 MARKS
- *MathTask* – this class provides an implementation of the Task interface and is used to perform some calculation that returns an Integer object. The calculation itself can be just some simple arithmetic e.g. add two numbers. 6 MARKS
- *ComputeServer* - this class should provide an implementation of the Compute interface as well as the code required to initialise the server and make the remote object locatable for clients in the RMI registry. The server runtime should be protected so that objects uploaded to the server can not cause any harm. 6 MARKS
- *ComputeClient* – this should provide a simple client program that creates a MathTask object and submits it to the server for remote execution and then displays the result. The client runtime should be protected so that objects downloaded from the server can not cause any harm. 5 MARKS

- 2.a: What kind of applications can use Node.js? What is unique about Node.js when compared to other server technologies like e.g. the Apache web server?

4 MARKS

- b: Explain briefly the purpose of the **npm** utility. Describe exactly the purpose and the effect of running the following command:

`npm install ejs -g`

5 MARKS

- c: In the context of implementing a web server type application in Node.js what are the advantages of using the **Express** framework? Write the Node.js code to implement a simple web server, using the Express framework, that responds with a simple text message when the URI **/main** is invoked.

7 MARKS

- d: You have been asked to develop a web based Todo list application using Node.js and related technologies and the architecture should follow a Model-View-Controller type approach. Based on these requirements, describe a suitable top-level application architecture. Identify the technologies and additional Node.js modules that will be used and explain the role each of these technologies plays in the overall system architecture.

9 MARKS

- 3.a: What is *message oriented middleware* and what types of messaging models are available in the Java Messaging Service?

5 MARKS

- b: You are required to design an application that allows programmers to submit votes for their favourite programming language. Describe a suitable architecture and design for a distributed application that uses the Java Messaging Service (JMS) to submit these votes as messages to a queue. Another related application should similarly use JMS to consume these messages from the queue and tally votes. Full Java source code is not required but your answer should provide a full description of how the JMS could be used within the application. Also describe how the application might use the Java Naming and Directory Interface (JNDI) as part of this solution.

10 MARKS

- c: Assume that you have been contracted by a large multinational company to develop an enterprise class client / server application that may be accessed by a large number of clients concurrently. You will therefore need to employ some form of load balancing in the design of the application. What type of load balancing systems would you recommend? In this context, include both low level load balancing algorithms and high level load balancing mechanisms such as round-robin DNS and IP Anycast using BGP. Provide some real world examples of systems or services that use DNS and IP Anycast.

10 MARKS

- 4.a: What operating system is the Proxmox Virtualization Environment (PVE) based on? Would it be correct to call Proxmox a hypervisor? What is the basic purpose of Proxmox? What does the term “VM Migration” mean in this context?
4 MARKS
- b: What kind of hardware does the Ceph storage platform require and what advantages does it have over traditional RAID based storage? Describe the main components of the Ceph storage platform.
6 MARKS
- c: Explain how using the Apache Hadoop Distributed File System and its related facilities might help in solving the storage and analysis requirements of an internet search engine company that collects a lot of very large data sets. Discuss the advantages of this approach over using traditional relational database systems for this type of data.
7 MARKS
- d: Describe the architecture for a MapReduce application that could be used to index a large number of text files by the individual words present in each file. Full source code for the application is not required but your answer should clearly explain the purpose and functionality of the map() and reduce() functions in solving this problem.
8 MARKS
- 5.a: Describe briefly the advantages of using the EJB component framework in the context of high volume distributed object applications. What types of beans may be defined using the EJB framework?
5 MARKS
- b: Web Services represent an evolution and convergence of a number of important areas of technology and business. Describe briefly these technology areas and explain how Web Services builds on previous capabilities. Include in your explanation an overview of the main enabling technologies used to provide Web Services.
10 MARKS
- c: You have been asked to develop a commercial online bookstore using J2EE based technologies. The bookstore architecture and design should be able to support different types of client browsers and should use a three-tier application model i.e. a client tier to support different clients, a middle tier that implements the application business logic and an information tier to persist the application state. Based on these requirements, describe the top-level application architecture. Identify the technologies that will be used and explain the role each of these technologies plays in the overall system architecture.
10 MARKS